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(54) **METHOD AND SYSTEM FOR PROVIDING VERSION CONTROL OF PARAMETERS IN A COMMAND-BASED API USING JAVA SERIALIZATION**

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See application file for complete search history.

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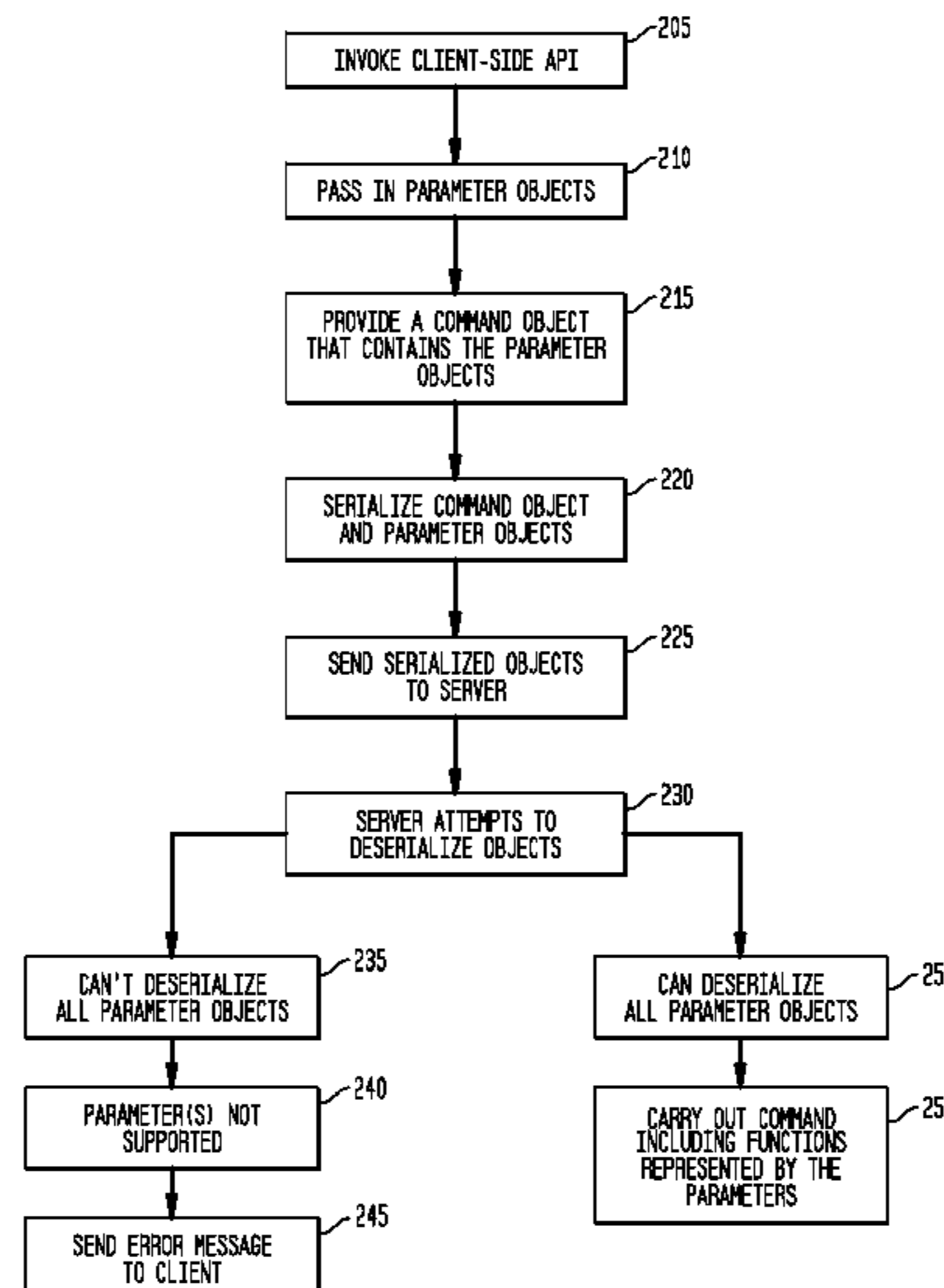
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(57) **ABSTRACT**

A technique for determining whether a server host supports the functions in a command sent by a client host. The client host formulates a command including a command object that contains parameter objects. The parameter objects, which represent the functions, are serialized, e.g., using the Java serialization command, and communicated to the server host. The server host attempts to deserialize the parameter objects. If it is successful, it is concluded that the server host supports the functions represented by the parameter objects. Or, it is concluded that the server host is incompatible with the functions represented by one or more parameter objects that cannot be deserialized. The server host may be a storage server, and the functions may be storage-related, such as a copy type to be performed.

4 Claims, 2 Drawing Sheets



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FIG. 1

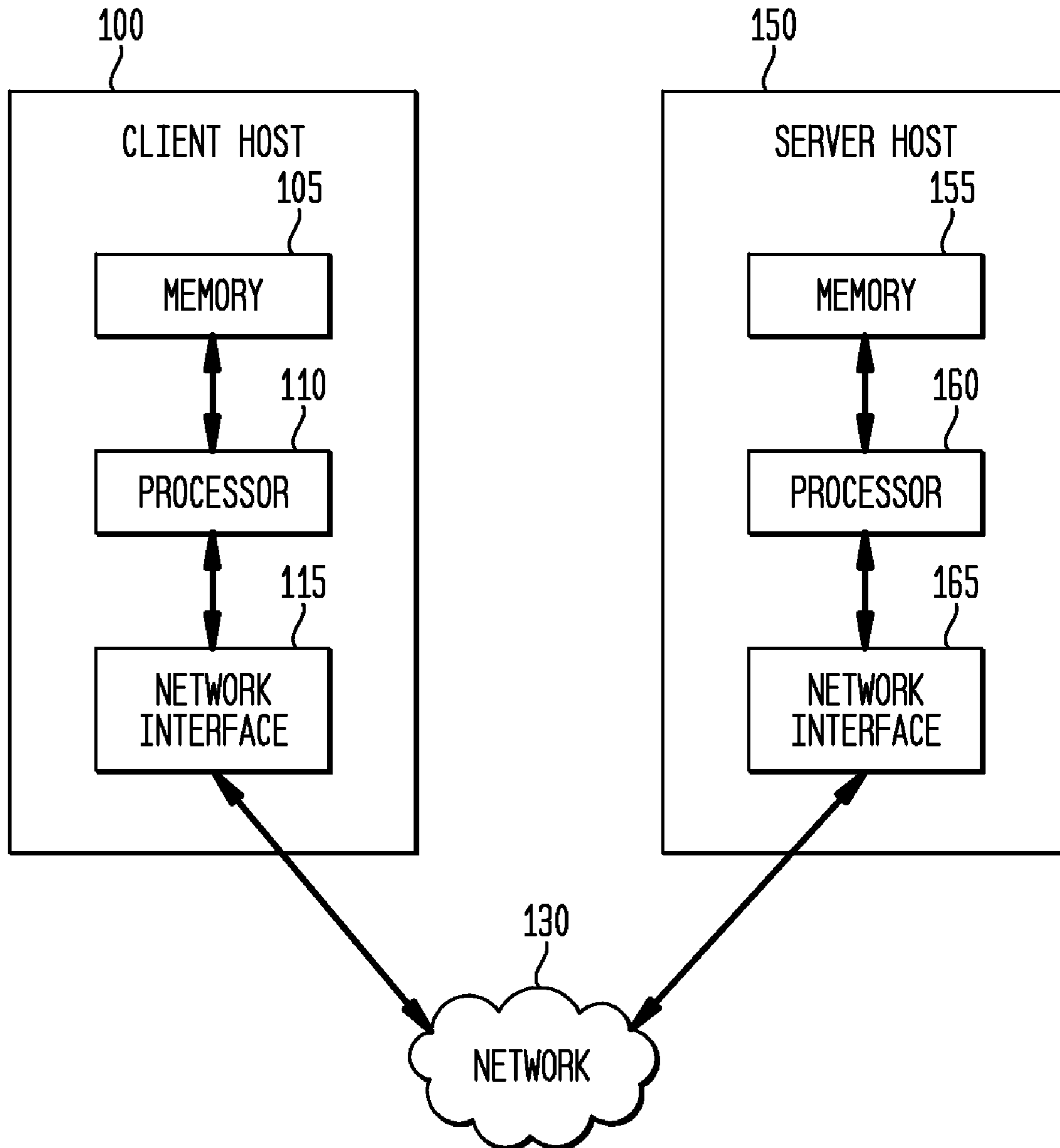
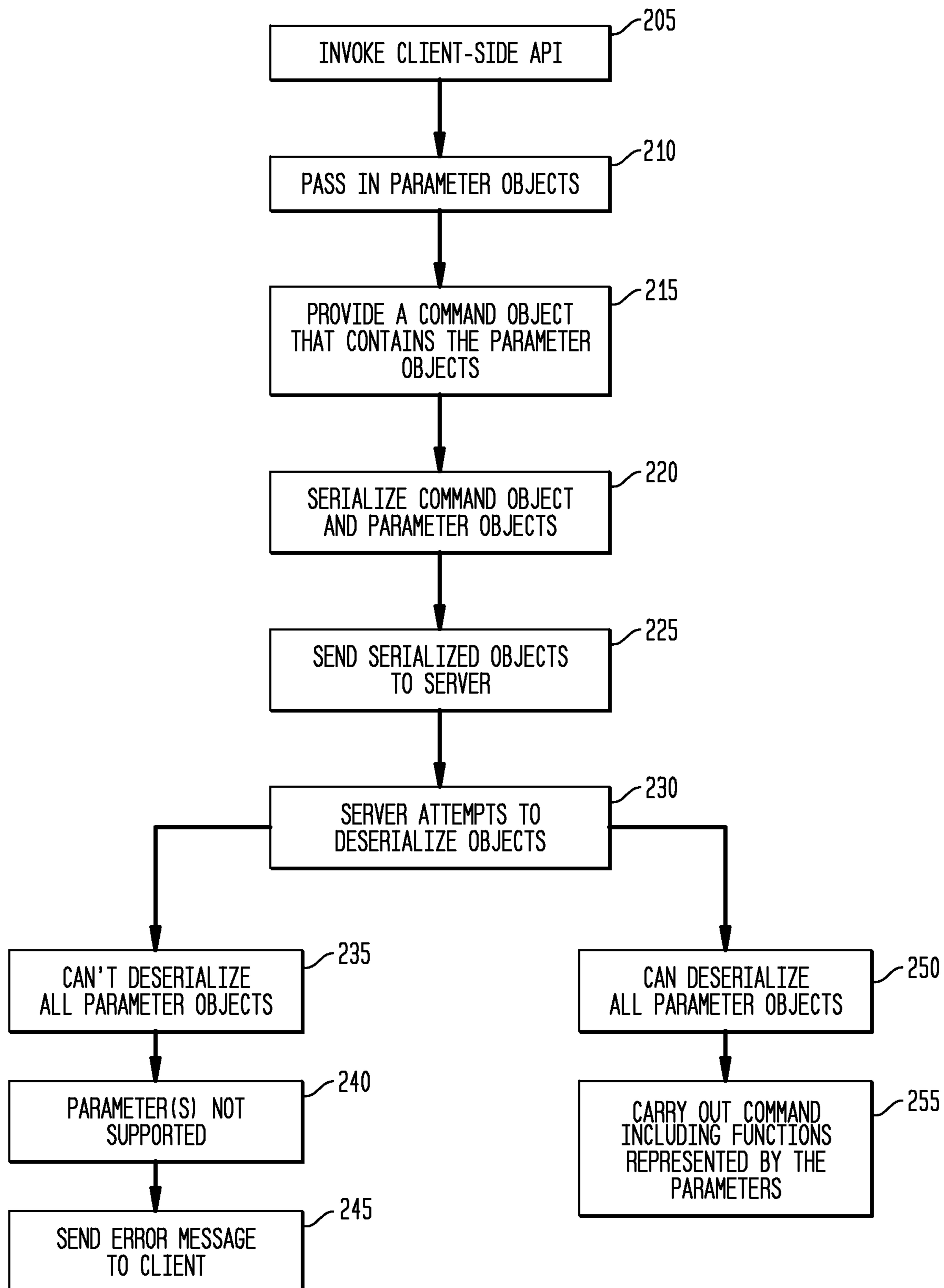


FIG. 2



1

**METHOD AND SYSTEM FOR PROVIDING
VERSION CONTROL OF PARAMETERS IN A
COMMAND-BASED API USING JAVA
SERIALIZATION**

RELATED APPLICATION

This application is a continuation of U.S. Ser. No. 10/697, 761, filed Oct. 30, 2003, now U.S. Pat. No. 7,409,693, the entire contents of which are incorporated herein by reference.

BACKGROUND OF THE INVENTION

1. Field of the Invention

The invention relates generally to the field of computer systems and, more specifically, to a technique for determining whether a server-side host supports a command provided by a client-side host.

2. Description of the Related Art

Computer systems include host computers that communicate with one another via a network to run network applications. Typically, software is distributed and run on two or more hosts to realize the application. The network applications have application-layer protocols that define the format and order of the messages that are exchanged between the hosts, and what actions to take when a message is transmitted or received. In particular, a network application typically includes a client side and a server side. In this case, the application may be referred to as a client/server application. A client side on one host may communicate with a server side on another host. The client is usually the host that initiates a communication or session with another host.

However, difficulties arise when the client host and server host are running different versions of the network application or other software. In this case, the client may provide a command to the server requesting it to perform a specific function that the server does not support. Various approaches have been developed to address this problem. For example, the client may send additional data to the server such as a code-word that identifies the version the client is using. However, this approach lacks generality and requires that a special protocol for coding and decoding the version data be implemented.

BRIEF SUMMARY OF THE INVENTION

To overcome these and other deficiencies in the prior art, the present invention provides a technique for determining whether a server supports different functions that are represented by parameter objects in a command that is sent to a server-side host by a client-side host.

In a particular aspect of the invention, a method for providing a command from a client-side host to a server-side host is provided. The method includes invoking a client-side application programming interface (API) at the client-side host to pass in a set of parameter objects, and to provide a command object that contains the parameter objects; wherein each of the parameter objects represents a different parameter of a command; serializing the command and parameter objects to provide serialized command and parameter objects; and communicating the serialized command and parameter objects to the server-side host as the command.

In another aspect of the invention, a method for processing a command from a client-side host at a server-side host is provided. The method includes receiving serialized command and parameter objects at the server-side host as a command from the client-side host; wherein the command object

2

contains the parameter objects, and each of the parameter objects represents a different parameter of the command; and deserializing the serialized command and parameter objects to determine whether the server-side host is compatible with the different parameters represented by the parameter objects. A related program storage device is also provided.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other features, benefits and advantages of the present invention will become apparent by reference to the following text and figures, with like reference numbers referring to like structures across the views, wherein:

FIG. 1 illustrates a client-side host and a server-side host in a computer system; and

FIG. 2 illustrates a method for providing version control.

DETAILED DESCRIPTION OF THE INVENTION

Generally, the present invention provides a technique for providing version control of parameters in a command-based, client-server network application programming interface (API). In a client-server network API, the levels of functionality supported by the client and server may differ. Moreover, in a command-based API, new functionality may be represented as new additional parameters to the commands. For example, for a server host in a storage subsystem, the functions may be storage-related. The functions may specify, e.g., a copy type to be performed, a location to store data, or other storage action to be taken. For instance, in the IBM® Enterprise Storage Server (ESS) storage subsystem, one function may be a normal, continuous flash copy (an instant copy of data, such as a point-in-time copy of a volume), while another function may be an incremental flash copy. The functions may also be thought of as optional features that may or may not be supported by different server hosts. The programming challenge is how to determine if a specific parameter of a command from the client portion of the API is supported by, e.g., compatible with, the server portion of the API. The present invention addresses this challenge by using Java deserialization of class type to determine if the server supports a specific parameter and the function represented by the parameter.

FIG. 1 illustrates a client-side host **100** and a server-side host **150** in a computer system. The client host **100** includes a processor **110**, memory **105** and network interface **115**, while the server host **150** similarly includes a processor **160**, memory **155** and network interface **165**. The network interfaces **115** and **165** communicate with one another via a network **130** such as the Internet. The client-side host **100** may implement a client-side API that comprises a client-side of a command-based API, while the server-side host **150** may implement a server-side API that comprises a server-side of the command-based API. In a command-based API, one or more hosts send commands to one or more other hosts. For example, a command-based API may be used by a storage subsystem host and remote hosts that send data to the storage subsystem host to be backed up. The remote hosts may issue commands to the storage subsystem host to instruct it to backup their data, or to retrieve previously backed up data, for instance.

The general operation and configuration of the processors **110**, **160**, memories **105**, **155** and network interfaces **115**, **165** is well known in the art and is therefore not described in detail. The components illustrated are provided to assist in understanding the invention. The hosts **100**, **150** may be general-purpose computers, workstations, servers, portable devices such as PDAs, or other computer devices. The func-

3

tionality described herein can be achieved by configuring the hosts **100** and **150** with appropriate software. In one approach, the software comprises an object-oriented software such as Java code that is stored in the memories **105**, **155**. In this case, the memories **105**, **155** are program storage devices. The software is executed using the processors **110**, **160** in a known manner.

FIG. 2 illustrates a method for providing version control. At block **205**, the client-side API method is invoked at the client host **100**, passing in a set of parameter objects (block **210**). At block **215**, a command object is provided that contains the parameter objects. At block **220**, the command object and parameter objects are serialized by the client host's code, such as Java code. At block **225**, the serialized objects are sent from the client host **100** to the server host **150** over the network **130**. The server host **150** receives the serialized parameters and, at block **230**, attempts to deserialize them. The serialized command object is also received and deserialized. If the server host **150** can't successfully deserialized all of the parameter objects (block **235**), e.g., the Class type of one or more of the parameters is not known by the server host **150**, it is concluded that the server host **150** does not support the one or more parameters that cannot be successfully deserialized (block **240**). In this case, the server host **150** may send an error message to the client host **100** informing it that the one or more parameters are not supported. The client host **100** may then decide, e.g., to reformulate its command so that the one or more unsupported parameters are not included, or to locate another server host that may be compatible with the one or more parameters in question. If the server host **150** can successfully deserialize all of the parameter objects (block **250**), it carries out the command, including the functions represented by the parameters (block **255**).

Specifically, in accordance with the invention, each new parameter for a command based API is defined as a unique new Java Class type. Each parameter Class may or may not contain data. Java Serialization is used to transmit parameters from a Java Client, e.g., client host **100**, to a Java Server, e.g., server host **150**. Whenever a new parameter (class) is added to the client host **100**, and the parameter is sent to the server host **150**, the server host **150** will either deserialize the parameter successfully if the server supports the functionality represented by the parameter, or fail to successfully deserialize it, indicating that the server does not support the parameter/functionality. A particular advantage of this technique for providing version control is that only one definition for a parameter is required. The version control information and the functionality are contained within one object, so no additional, separate version control data is needed. The Class type itself is the only unique data necessary to determine whether the API at the server host **150** supports a given functionality. Thus, an important aspect of the invention is how the classes for commands and parameters are organized. Example declarations of classes are provided further below.

Serialization is the process of converting an object to a byte stream. Deserialization is the opposite process. When an object is serialized, information about its class and other objects that it refers to is also saved. To serialize an object using Java, an object is passed as an argument to the writeObject() method of an object of class java.io.ObjectOutputStream which, in turn, is built from an object of class java.io.FileOutputStream. Moreover, an object is serializable when its class implements the Serializable interface. This is an empty interface that doesn't contain any method declarations, but simply identifies classes whose objects are serializable. During deserialization, the readObject() method is invoked on an object of class java.io.ObjectInputStream, which is

4

built upon a java.io.FileInputStream object. If the server host **150** cannot locate a class file needed to make sense of a parameter object during deserialization, the exception java.lang.ClassNotFoundException is thrown.

Example code for performing serialization is as follows:

```

Class Command1 implements Serializable{
    Parameter[] parms;
    Public Command1(Parameter[] parms);
};
Class Parameter implements Serializable { };
Class ParameterA { } extends Parameter {
    Public static ParameterA Option = new ParameterA( );
};
Class ParameterB { } extends Parameter{
    Public static ParameterB Option = new ParameterB( );
}

```

// Example code to create command and serialize:

```

Parameter[] parms = {ParameterA.Option, ParameterB.Option}
Command1 commandInstance = new Command1(parms);
outputStream.writeObject(commandInstance);

```

Example code for performing deserialization is as follows:

```

Try {
    Command1 command = (Command1) inputStream.readObject( );
} catch (ClassNotFoundException) {
    // This means the command is not supported
    handleNotSupported( );
}

```

Generally, the command serialization and parameter serialization are recursive. The process can be outlined as follows:

- 1) A Command contains Parameters.
- 2) Code invokes Command.writeObject().
- 3) Command.writeObject method knows that in order to serialize a Command object, it must serialize everything contained within that object.
- 4) So, then Command.writeObject() invokes Parameter.writeObject().
- 5) Parameter.writeObject() knows that in order to serialize a Parameter object, it must serialize everything contained within the Parameter.
- 6) All parameter data is serialized at this point. Parameter serialization is done.
- 7) Control turns back to Command.writeObject(). All Parameters have been serialized. Any other data in Command is serialized and Command Serialization completed.
- 8) Command.writeObject completes.

Moreover, the process may be analogized to nested Russian dolls. For instance, say we had three nested Russian dolls—big, medium and small. The top call would be to BigDoll.writeObject(), which under the covers would invoke MediumDoll.writeObject(), which under the covers would invoke LittleDoll.writeObject(). Deserialization is similar (outside→in).

While the above examples are provided using Java™, which is a high-level object-oriented programming language developed by Sun Microsystems, Inc., the invention is suitable for use with other object-oriented programming languages as well.

5

The invention has been described herein with reference to particular exemplary embodiments. Certain alterations and modifications may be apparent to those skilled in the art, without departing from the scope of the invention. The exemplary embodiments are meant to be illustrative, not limiting of the scope of the invention, which is defined by the appended claims.

What is claimed is:

1. A program storage device, tangibly embodying a program of instructions executable by a server-side host to perform a method for processing a command from a client-side host, the method comprising:

receiving a serialized command and parameter objects at the server-side host as the command from the client-side host, the serialized command and parameter objects obtained by invoking a client-side application programming interface (API) at the client-side host to pass in a set of parameter objects, and to provide a command object that contains the parameter objects, wherein each of the parameter objects represents a different parameter of a command, said different parameter representing a different function and each new parameter for the command is defined as a unique new class type, and serializing the command and parameter objects to provide serialized command and parameter objects;

deserializing, by said server-side host, the serialized command and parameter objects to determine whether the server-side host is compatible with the different parameters of the command that are represented by the param-

6

eter objects, the server-side host determining that the server-side host is not compatible with one or more of the different parameters if the server-side host does not support a class type associated with said one or more of the different parameters, and

reformulating, by said client-side host, the command to delete one or more parameters determined to be incompatible, wherein:

if the server-side host cannot successfully deserialize at least one of the serialized parameter objects, the server-side host sends an error message to the client-side host to inform the client-side host that the server-side host does not support the parameter represented by the at least one serialized parameter object that cannot be successfully deserialized.

2. The program storage device of claim 1, wherein: the server-side host cannot successfully deserialize the serialized parameter objects whose class type is not recognized by the server-side host.

3. The program storage device of claim 1, wherein: the server-side host uses a server-side API of a command based API to attempt to deserialize the serialized command and all parameter objects.

4. The program storage device of claim 3, wherein: the serialized command and parameter objects are obtained at the client-side host by invoking a client-side API at the client-side host that comprises a client-side of the command-based API.

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